UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and
Information Administration
Washington, D.C. 20230
DOCKET FILE COPY ORIGINAL

June 21, 1999

RECEIVED
JU 2 1999

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
The Portals
445 Twelfth Street, S.W.
Washington, D.C. 20554

Re: Amendment of Parts 2 and 25 to Implement the Global Mobile Personal Communications by Satellite (GMPCS) Memorandum of Understanding and Arrangements, Petition of National Telecommunications and Information Administration to Amend Part 25 of the Commission's Rules to Establish Emissions Limits for Mobile and Portable Earth Stations Operating in the 1610-1660.5 MHz Band, IB Docket No. 99-67, RM No. 9165

Dear Ms. Salas:

Enclosed please find one original and six copies of the Comments of the National Telecommunications and Information Administration in the above-referenced docket and rulemaking. The comments were also submitted in electronic form on two diskettes in WordPerfect 5.1 to Paul Gordon with your office and delivered to the Commission's copy contractor, International Transcription Service.

Please direct any questions you may have regarding this filing to the undersigned. Thank you for your cooperation.

Respectfully submitted,

Kathy Smith
Acting Chief Counsel

cc: Paul Gordon, Office of the Secretary
International Transcription Service

Enclosures

No. of Copies rec'd 0+6
List ABCDE

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

RECEIVED

JUL 21 1999

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 to Implement the Global Mobile Personal Communications by Satellite (GMPCS) Memorandum of Understanding and Arrangements	)	IB Docket No. 99-67
	)	
Petition of the National Telecommunications and Information Administration to Amend Part 25 of the Commission's Rules to Establish Emissions Limits for Mobile and Portable Earth Stations Operating in the 1610-1660.5 MHz Band	)	RM No. 9165

COMMENTS OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

Larry Irving
Assistant Secretary for
Communications and Information

Kathy Smith
Acting Chief Counsel

William Hatch
Acting Associate Administrator
Office of Spectrum Management

Edward Drocella
David Anderson
Electronics Engineers
Office of Spectrum Management

National Telecommunications and
Information Administration
U.S. Department of Commerce
Room 4713
1401 Constitution Avenue, N.W.
Washington, DC 20230
(202) 482-1816

June 21, 1999

Table of Contents

EXECUTIVE SUMMARY

The National Telecommunications and Information Administration (NTIA) applauds the Commission for its efforts in implementing the international Global Mobile Personal Communications by Satellite Memorandum of Understanding (GMPCS MOU) which will support the deployment of GMPCS service in the United States and around the world. As discussed in these comments, NTIA remains concerned about a number of issues vital to the future needs and operations of the Federal aeronautical radionavigation community and implementation of the Global Navigation Satellite System (GNSS) and its constituent elements the United States Global Positioning System (GPS) and the Russian Federation Global Navigation Satellite System (GLONASS).

The GPS Standard Positioning Service (SPS) Signal Specification has been amended in recognition that many civil GPS receivers utilize the entire transmitted bandwidth of the Coarse/Acquisition code signal to minimize tracking errors due to noise, interference, and multipath. NTIA requests that the Commission modify Section 25.213(b) of the Commission's Rules, 47 C.F.R. § 25.213(b), to reflect the amended SPS Signal Specification by replacing the current frequency range of 1574.397-1576.443 MHz with the new frequency range of 1563.42-1587.42 MHz.

In the study performed by RTCA Special Committee 159 (SC-159), it was concluded that GLONASS requires the same level of interference protection as GPS. This conclusion supports NTIA's recommendation that a wideband limit of -70 dBW/MHz and a narrowband limit of -80 dBW is required to protect aircraft reception of GLONASS signals in the 1597-1605 MHz portion of the band.

NTIA believes that as a result of the limited carrier-to-noise density margin, the higher interference levels associated with Category II/III precision approach landing, and the potential of multiple interfering sources, the susceptibility levels for GNSS receivers cannot be reduced from the level used to develop the proposed out-of-band emission limits for mobile-satellite service (MSS) terminals operating in the 1610-1660.5 MHz band. Moreover, NTIA does not believe that interference suppression techniques should be used as a substitute for GNSS receiver protection limits.

NTIA agrees with the Commission's proposal to specify the narrowband out-of-band emission limit for MSS terminals as an absolute level of -80 dBW. It is appropriate to specify narrowband emissions in terms of an absolute power level and it is consistent with the recommendation made by RTCA SC-159.

NTIA believes that it is beneficial to MSS operators and GNSS receiver manufacturers to establish out-of-band emission limits in the 1605-1610 MHz band instead of resolving interference on a case-by-case basis. Therefore, NTIA recommends that the Commission adopt the out-of-band emission limits established by the International Telecommunications Union - Radiocommunication Sector (ITU-R) and the European Testing and Standards Institute (ETSI) in the 1605-1610 MHz portion of the band.

NTIA agrees with the Commission that design decisions should be left to the MSS system providers. NTIA believes that if the Commission adopts rules that will require all MSS terminals operating in the 1610-1660.5 MHz band to meet the wideband limit of -70 dBW/MHz and the narrowband limit of -80 dBW in the 1559-1605 MHz by January 1, 2005, approval of hardware/software configurations would not be necessary.

The NTIA Petition proposed that out-of-band emission power levels should be averaged over a 20 millisecond time interval. This power level was based on the symbol duration of the GPS navigation message. Since the NTIA petition was filed, the Wide Area Augmentation System (WAAS) has continued to develop. The WAAS signal will augment GPS to obtain the required accuracy improvement for precision approaches, as well as integrity, continuity, and availability of navigation for all phases of flight. Because the WAAS transmits more data than GPS it has a symbol duration that is 10 times shorter than a GPS data symbol, making WAAS more susceptible to pulsed interfering signals. As a result of this increased susceptibility to pulsed interference, NTIA proposes that the out-of-band emissions for MSS systems employing Time Division Multiple Access (TDMA) techniques be averaged over a time interval of duration that is equal to the length of the transmission time slot. This would only apply to future MSS systems employing TDMA. For existing MSS systems employing TDMA the 20 millisecond averaging time interval should be used.

NTIA disagrees agree with the Commission's assertion that Little LEO terminals operating in compliance with Section 25.202(f) of the Commission's Rules, 47 C.F.R. § 25.202(f), will not exceed the wideband and narrowband limits proposed by NTIA in the 1559-1610 MHz band.

NTIA recommends that the Commission adopt a limit for the carrier-off state of an MSS earth terminal that is 10 dB lower than the carrier-on limit to account for a cumulative power effect.

NTIA believes that based on the continuing evolution of the 1559-1610 MHz band that it would be ill-advised to waive or postpone the 2002 compliance date for new non-geostationary

MSS terminals that is proposed in NTIA's petition. However, NTIA does agree that there is some uncertainty for the date of domestic implementation of GLONASS. The status of GLONASS implementation should be reviewed in the 2005 timeframe and the date for invoking the final stages of compliance can be adjusted accordingly.

NTIA proposes that geostationary MSS terminals operating in the 1626.5-1660.5 MHz band that are brought into service after January 1, 2002, be required to comply with the final emission limits of -70 dBW/MHz and -80 dBW. Geostationary MSS terminals that are currently in service or those brought onto service prior to January 1, 2002 should be permitted to operate at their current out-of-band emission levels until January 1, 2005. NTIA believes that this will lessen the burden on manufacturers allowing them adequate time to redesign their terminals to comply with the final emission limits.

NTIA believes that a user in need of emergency assistance should receive help independent of which type of wireless device that person is using. This should be independent of whether the network is terrestrially based like cellular or PCS or satellite-based like GMPCS. Since the ability to locate users in distress is in the public's best interest, NTIA supports position location capabilities for GMPCS terminals authorized for use in the United States.

NTIA requests clarification regarding the types of earth terminals that are to be exempted from the certification requirement proposed by the Commission in this NPRM. NTIA does not object to the Commission expanding the types of terminals considered under the GMPCS-MoU to include semi-fixed and fixed terminals. Such action, however, would require that national and international standards similar to those adopted for the MSS earth terminals be developed for the essential technical parameters of semi-fixed and fixed GMPCS earth terminals.

The United States Coast Guard (USCG) is considering developing interference susceptibility standards for maritime RNSS receivers. The results of the work performed by the USCG may have to be considered in a future rulemaking on the uses of RNSS other than aeronautical.

The National Science Foundation (NSF) requests that the Commission explicitly document in a Report and Order the protection of radio astronomy operations in the 1610-1613.8 MHz band. NSF is also concerned that the out-of-band emissions of MSS earth terminals operating below 1660 MHz may cause interference to radio astronomy observations in the 1660-1670 MHz band. Based on further studies and experience it may be necessary to revisit this issue and request tighter out-of-band emission standards or to introduce other measures.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 to Implement the Global Mobile Personal Communications by Satellite (GMPCS) Memorandum of Understanding and Arrangements	)	IB Docket No. 99-67
	)	
Petition of the National Telecommunications and Information Administration to Amend Part 25 of the Commission's Rules to Establish Emissions Limits for Mobile and Portable Earth Stations Operating in the 1610-1660.5 MHz Band	)	RM No. 9165

COMMENTS OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

The National Telecommunications and Information Administration (NTIA), an Executive Branch agency within the Department of Commerce, is the President's principal adviser on domestic and international telecommunications policy, including policies relating to the Nation's economic and technological advancement in telecommunications. Accordingly, NTIA makes recommendations regarding telecommunications policies and presents Executive Branch views on telecommunications matters to the Congress, the Federal Communications Commission, and the public. NTIA, through the Office of Spectrum Management, is also responsible for managing the Federal Government's use of the radio frequency spectrum. NTIA respectively submits the following Comments in response to the Commission's Notice of Proposed Rulemaking in the above-captioned proceeding.[1]

---

[1] *Amendments of Parts 2 and 25 to Implement the Global Mobile Personal Communications by Satellite (GMPCS) Memorandum of Understanding and Arrangements and*

I. INTRODUCTION

In October 1994, the Commission issued a Report and Order establishing rules for the "Big LEO" service, *i.e.*, voice-and-data mobile satellite service (MSS) provided by non-geostationary satellites accessed by mobile terminals transmitting in segments of the 1610-1626.5 MHz band.[2] The rules included out-of-band emission limits to protect reception of the Global Positioning System (GPS) Coarse/Acquisition (C/A) signals.[3] Although U.S. consultations with Russian officials indicated a likelihood that the Global Navigation Satellite System (GLONASS) would shift to frequencies below 1605 MHz by the year 2005, the Commission acknowledged that emissions from Big LEO terminals could potentially interfere with GLONASS reception below 1610 MHz in the interim. The Commission refrained from adopting specific out-of-band limits to protect GLONASS, however, leaving the issue to be resolved after further study.

In November 1994, representatives of the Commission, the Federal Aviation Administration (FAA), and the NTIA signed a Memorandum of Understanding ("1994 MOU") concerning domestic implementation of a GPS/GLONASS Global Navigation Satellite System (GNSS).[4] The 1994 MOU declared that the Commission would consider adopting pertinent out-

---

Petition of the National Telecommunications and Information Administration to Amend Part 25 of the Commission's Rules to Establish Emissions Limits for Mobile and Portable Earth Stations Operating in the 1610-1660.5 MHz Band, IB Docket No. 99-67 and RM No. 9165, FCC 99-37 (rel. March 5, 1999) (hereinafter "GMPCS NPRM").

[2] *Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5/2483.5-2500 MHz Frequency Bands*, Report and Order, CC Dkt. No. 92-166, 9 F.C.C. Rcd. 5936 (1994).

[3] 47 C.F.R. § 25.213(b).

[4] The GNSS also includes the Space Based Augmentation Systems (SBAS) and Ground Based Augmentation Systems (GBAS). In the United States the SBAS is the Wide Area

of-band emissions limits for MSS terminals recommended by the RTCA,[5] and that licenses for MSS terminals operating in the bands near the GPS and GLONASS bands issued prior to a U.S. decision to implement GLONASS domestically would indicate that the licensees would be bound by any such limits subsequently incorporated in the Commission's rules. The MOU pertained to all MSS terminals transmitting on assigned frequencies between 1610 and 1660.5 MHz.

In January 1997, Special Committee 159, the RTCA committee that had been commissioned pursuant to the 1994 MOU to study the potential for harmful interference with GNSS operation, issued its final report.[6] The aviation and MSS participants agreed that a wideband equivalent isotropically radiated power (EIRP) limit of -70 dBW/MHz and a narrowband EIRP limit of -80 dBW would protect aircraft reception of GPS signals, and the MSS participants agreed that it was feasible for them to meet those limits in the GPS Coarse/Acquisition signal band. No consensus, however, was reached regarding limits for the protection of GLONASS operations. The aviation representatives maintained that a -70 dBW/MHz wideband limit and a -80 dBW narrowband limit were necessary. The MSS representatives maintained that it was economically infeasible for them to suppress emissions in the GLONASS band to that extent and argued that limits of -54 dBW/MHz for wideband emission and -64 dBW for narrowband emissions would be adequate. As a result of this lack of

---

Augmentation System (WAAS) and the GBAS is the Local Area Augmentation System (LAAS). These augmentation systems are capable of supporting both GPS and GLONASS signal formats.

[5] RTCA, Inc., formerly known as the Radio Technical Commission for Aeronautics, is a voluntary government/industry group that performs studies and makes recommendations pertaining to radio use for aviation.

[6] RTCA Inc., Special Committee No. 159, *Assessment of Radio Frequency Interference Relevant to the GNSS*, Document No. RTCA/DO-235 (RTCA/DO-235) (Jan. 27, 1997).

consensus, RTCA SC-159 did not issue a recommendation for the out-of-band emissions to protect GLONASS.

After the release of the RTCA report, interested private sector parties and officials at the Commission, the NTIA, and the FAA conducted informal discussions concerning emission limits for the protection of GNSS in the United States. At the culmination of those discussions, NTIA filed the petition for rulemaking that is in part the subject of this GMPCS NPRM.[7] The NTIA Petition reflects a compromise proposal worked out by the NTIA, the FAA, and the representatives of Big LEO MSS systems. Under the proposal set forth in the NTIA Petition, the out-of-band emission standard that the aviation members of RTCA SC-159 had recommended would be adopted for the protection of aircraft reception of GLONASS signals between 1597 and 1605 MHz, but there would be an initial grace period during which less restrictive limits would apply for emissions in that portion of the band, and no specific limits were proposed for protection of GLONASS reception on frequencies above 1605 MHz.

For protection of GPS reception, the NTIA Petition recommended requiring that all MSS terminals transmitting on frequencies between 1610 MHz and 1660.5 MHz conform to two restrictions: a wideband limit of -70 dBW/MHz, averaged over 20 milliseconds on the EIRP density of the out-of-band emissions in the 1559-1580.42 MHz frequency range; and a narrowband limit of -80 dBW/700 Hz, also averaged over 20 milliseconds on emissions in the 1559-1585.42 MHz frequency range.

---

[7] NTIA Petition for Rulemaking, Amendment to the Commissions Rules to Incorporate Mobile Earth Station Out-of-Band Emissions, RM No. 9165 (Sept. 19, 1997)(placed on Public Notice, Report No.2227 (Sept. 23, 1997)).

The NTIA Petition also recommended a three-phased approach for protection of aircraft reception of GLONASS to ease the initial burden of compliance for MSS operators. In the first phase, MSS terminals transmitting on frequencies in the 1610-1626.5 MHz band that are placed into service prior to January 1, 2002 must, in addition to meeting the requirements described in the preceding paragraph, immediately meet an interim EIRP density limit of -64 dBW/MHz for wideband emissions in the 1580.42-1605 MHz range and a narrowband EIRP density limit of -74 dBW/700 Hz in the 1585.42-1605 MHz range. In the second phase, all MSS terminals licensed for operation on frequencies between 1610 and 1660.5 MHz commissioned after January 1, 2002 must meet limits of -70 dBW/MHz and -80 dBW/700 Hz throughout the 1559-1605 MHz band without relying on software restriction of operating frequencies. In the third phase, MSS terminals commissioned before January 1, 2002 must be deactivated as of January 1, 2005 unless they are altered by then, as necessary, to conform to the -70/-80 limits throughout the 1559-1605 MHz band.[8]

NTIA also recommended that any issue concerning potential interference with reception of GLONASS signals in the U.S. territory on frequencies above 1605 MHz should be addressed on a case-by-case basis.[9]

Since NTIA filed its petition for rulemaking, the Commission proposed voluntary interim equipment certification procedures to be used prior to adopting final rules to implement the Global Mobile Personal Communications by Satellite (GMPCS) MOU which was signed by

---

[8] NTIA Petition at 2-3. For purposes of the NTIA Petition, the date commissioned means the date that an MSS terminal is activated and brought into service.

[9] *Id.* at 3.

the United States and over 120 additional parties in February 1997.[10] In this NPRM, the Commission proposed to certify all GMPCS-related terminal equipment that complies with the Commission's technical and other requirements for that service, including requirements governing emission limits. In addition, the Commission proposed that MSS terminals operating in the 1610-1626.5 MHz band would also have to meet the out-of-band emission limits recommended for implementation by the year 2005 by NTIA in its petition for rulemaking.

NTIA applauds the Commission for its efforts in implementing the international GMPCS-MOU which will support the deployment of GMPCS service in the United States and around world. These GMPCS systems will provide additional choices for delivery of seamless voice, data, and broadband services for consumers in all parts of the world. In particular, NTIA would like to commend the Commission for its decision to adopt rules governing the out-of-band emissions for MSS terminals essentially in accordance with NTIA's recommendation. The establishment of such rules strikes a reasonable balance between the public interest in fostering improvement in aeronautical radionavigation and providing GMPCS development. NTIA, however, offers the following comments to specific issues raised in the GMPCS NPRM that NTIA believes will likely have a direct and significant impact upon the future needs and operations of the Federal aeronautical radionavigation community.

---

[10] *1998 Biennial Regulatory Review – Amendment of Parts 2, 25, and 68 of the Commission's Rules to Further Streamline the Equipment Authorization Process for Radio Frequency Equipment, Modify the Equipment Authorization Process for Telephone Terminal Equipment, Implement Mutual Recognition Agreements and Begin Implementation of the Global Mobile Communications by Satellite (GMPCS) Arrangements*, Notice of Proposed Rulemaking, GEN Dkt. No. 98-68, 13 F.C.C. Rcd. 10683 (1998).

II. THE COMMISSION SHOULD MODIFY ITS RULES TO REFLECT THE AMENDMENT TO THE SPS SIGNAL SPECIFICATION.

The Commission describes the two GPS signals centered on a 1575.42 MHz (L1) carrier frequency: a C/A code signal primarily for civilian use and a 20 MHz wide Precision code signal for military and authorized civilian use.[11] Currently, Section 25.213(b) of the Commission's Rules, 47 C.F.R. § 25.213(b), provides that the bandwidth for the C/A code signal is 2.046 MHz wide extending from 1574.397 to 1576.443 MHz. This is consistent with the C/A code signal bandwidth definition in the 2nd Edition of the GPS Standard Positioning Service (SPS) Signal Specification that serves as the definitive reference source which delineates the GPS service provided to the civil community. Recently, however, the bandwidth definition of the GPS C/A code signal at 1575.42 MHz in the SPS Signal Specification was amended as follows:

> The L-band SPS ranging signal is a 2.046 MHz null-to-null bandwidth signal centered on L1. The transmitted ranging signal that comprises the GPS-SPS is not limited to the null-to-null signal and extends through the band 1563.42 to 1587.42 MHz.[12]

This amendment will be reflected in the upcoming 3rd Edition of the GPS SPS Signal Specification due for release later this year.

The SPS Signal Specification was amended in recognition that civil GPS receivers utilize the entire transmitted bandwidth of the C/A code signal to minimize tracking errors due to noise, interference, and multipath. The power dispersed over the bandwidth of a GPS signal is extremely important for high accuracy civilian safety-of-life applications for two reasons. First,

---

[11] *See GMPCS NPRM*, at ¶ 46.

[12] Letter from James R. Beale, Brig Gen, USAF Acting Deputy Assistant Secretary of Defense (C3ISR and Space Systems) to Mr. Joseph F. Canny, Deputy Assistant Secretary for Transportation Policy (Sept. 11, 1998).

the achievable tracking accuracy (in terms of ranging variance) of a signal is inversely proportional to the root-mean-square (RMS) signal bandwidth. The implication is that the further the signal power is dispersed from the carrier frequency, the more important it is in reducing nominal tracking errors. Second, the most effective multipath mitigation techniques for GPS rely on having a very sharp cross-correlation (between the incoming C/A code signal and the receiver replica) function. Sharpness of the cross-correlation function is provided by having a very wide bandwidth to capture the signal power well beyond the first lobe of the signal.

Since it is anticipated that many of the civilian applications that demand a higher degree of accuracy, including safety-of-life applications, will use the full transmitted bandwidth of the GPS C/A code signal, NTIA requests that the Commission conform Section 25.213(b) of its Rules to the amended SPS Signal Specification by replacing the current frequency range of 1574.397-1576.443 MHz with the new frequency range of 1563.42 - 1587.42 MHz.

III. GNSS RECEIVERS REQUIRE PROTECTION THROUGHOUT THE 1559-1605 MHz BAND.

The Commission requested comment on the assumptions underlying NTIA's recommendation to apply the -70 dBW/MHz limit in the 1597-1605 MHz band to protect aircraft reception of GLONASS signals.[13] The United States is making international commitments within the International Civil Aviation Organization (ICAO)[14] and the International Maritime

---

[13] *See GMPCS NPRM*, at ¶ 76.

[14] The requirements for civil aircraft operating precision approach phases of flight are defined in the ICAO GNSS Standards and Recommended Practices (SARPs). The SARPs establish the requirements necessary to protect GPS and GLONASS (GNSS) receivers from harmful interference.

Organization (IMO)[15] to participate in the development of GNSS. This entails providing protection to different elements of the GNSS, which include both GPS and GLONASS. The Russian Federation is implementing a three stage frequency transition plan for GLONASS.[16] After the year 2005, the GLONASS system will be in its final configuration where its highest carrier frequency will be 1604.25 MHz.[17] In the international frequency coordination process, the United States has committed to providing protection from interference to GLONASS in its final configuration. This protection from interference is to be consistent with standards established within the International Telecommunications Union-Radiocommunications Sector (ITU-R).[18]

User acceptance of the GNSS would be severely harmed if GLONASS availability was restricted by interference. It is therefore necessary that GLONASS receive the same protection from harmful interference that is afforded to GPS. RTCA Special Committee 159 (SC-159) determined that the out-of-band emission limits required to protect GPS would also be appropriate for GLONASS because:

1) GPS and GLONASS operate in the same frequency band with nearly identical hardware realizations.

2) GPS and GLONASS are both pseudo-random noise (PRN) modulated spread

---

[15] The requirement of the GNSS for maritime navigation is contained in an amendment to the Safety of Life at Sea (SOLAS) treaty document to be approved by the year 2000.

[16] Recommendation ITU-R M.1317, Considerations for Sharing Between Systems of Other Services Operating in Bands Allocated to the Radionavigation-Satellite and Aeronautical Radionavigation Services and the Global Navigation Satellite System (GLONASS-M).

[17] The United States is encouraging the Russian Federation to expedite the completion of the GLONASS frequency transition plan by the year 2000.

[18] Recommendation ITU-R M.1343, Essential Technical Requirements of Mobile Earth Stations for Global Non-Geostationary Mobile-Satellite Service Systems in the Bands 1-3 GHz.

> spectrum systems.
>
> 3) GPS is a code-division multiplex system with all satellites transmitting on the same frequency. GLONASS is a frequency division multiplex system with each satellite in view transmitting the same maximal length PRN code on a specific channel frequency. Neither method has any particular performance advantage over the other in principle.
>
> 4) The standard signal power received is similar (-160 dBW for GPS and -161 dBW for GLONASS) and both systems have the same data rate (50 Hz).
>
> 5) The code chipping rate for GPS is twice that of GLONASS (1.023 MHz for GPS and 0.511 MHz for GLONASS), and thus, GPS has a 3 dB higher theoretical spreading factor. The lower spreading factor for GLONASS is offset for wideband noise interference by its 3 dB narrower effective bandwidth.[19]

The net result is that the receiver susceptibility mask for GLONASS will be one-half the frequency scale of the GPS mask, but the broadband susceptibility will be the same on a per Hertz basis. Therefore, RTCA concluded that GLONASS requires the same level of interference protection as GPS.[20]

In addition to GPS and GLONASS, another radionavigation satellite service (RNSS) system that could be a component of the next generation of the GNSS has recently been Advanced Published with the ITU-R by the European Space Agency (ESA) for operation in the 1587.69-1609.17 MHz portion of the band. For this new RNSS system to be compatible with GPS and GLONASS, it must have a signal level at the surface Earth that is on the same order of magnitude as GPS and GLONASS, and therefore will require the same level of protection from interference. Given that the interference protection level is the same then the out-of-band emission limits required to protect the receivers using this new RNSS system would be the same.

---

[19] *See RTCA/DO-235,* at F-12.

[20] *Id.*

Thus, NTIA's recommendation that a wideband limit of -70 dBW/MHz and a narrowband limit of -80 dBW should be adopted to protect aircraft reception of RNSS signals in the 1597-1605 MHz portion of the band.

IV. INTERFERENCE SUSCEPTIBILITY LEVELS REQUIRED TO PROTECT GNSS RECEIVERS CANNOT BE REDUCED.

The Commission requested comment concerning measures that might be employed to minimize the interference susceptibility limit of GNSS receivers used in the susceptibility analysis in Appendix F of the RTCA/DO-235 report.[21] The analysis in Appendix F only considered the interference susceptibility of a GNSS receiver and its ability to meet Category I accuracy and continuity requirements and did not address the more stringent requirements of Category II/III precision approach landings. It also emphasizes that the aviation community has accepted the burden of making GNSS receivers more robust so that these receivers can tolerate the current out-of-band emission limits and still meet Category II/III approach specifications.

The interference susceptibility levels of GNSS receivers used in the Appendix F susceptibility analysis represent the interference levels to which manufacturers must design to meet navigation performance requirements. It does not represent the allowable level of interference. For GNSS receivers the critical performance parameter is the carrier-to-noise density ratio (C/N_0). The C/N_0 determines the performance of the GNSS receiver code and carrier tracking loops and directly impacts phase measurement accuracy, carrier cycle slip rate, navigation message bit/word error rate, and code tracking loop pseudorange accuracy. The GNSS receiver susceptibility level used in the Appendix F analysis results in only a 2.5 dB C/N_0

---

[21] *See GMPCS NPRM,* at ¶ 76.

margin, which is much smaller than the margins established for other ICAO approved navigation systems.[22] Moreover, unlike terrestrial radionavigation systems, the received GNSS satellite power is relatively fixed (*e.g.*, cannot increase power to overcome interference), thus the receivers operate over a smaller dynamic range.[23] Given the limited dynamic range and small C/N_0 margin any reduction in the interference susceptibility levels used to determine the out-of-band emission levels required to protect GNSS receivers is not possible.

In the development of the out-of-band emission limit for Category I operations, the Minimum Separation Distance (MSD) between the MSS terminal and the GNSS receiver based on the RTCA SC-159 "source-path-receiver" model was 100 feet.[24] For Category II/III operations the performance requirements (*e.g.*, accuracy, continuity, integrity) are substantially increased and the MSD is reduced to 50 feet. Since freespace propagation loss is proportional to the square of the separation distance, this implies 6 dB higher interference levels that GNSS receiver manufacturers must tolerate to satisfy Category II/III specifications. RTCA SC-159 concluded that this 6 dB of additional tolerance to interference will be difficult to obtain solely by improving the receiver design.[25]

[22] The ICAO Microwave Landing System (MLS) has a 6 dB C/N_0 margin and the ICAO Instrument Landing System (ILS) has an 8 dB C/N_0 margin.

[23] Dynamic range of a receiver is defined as the ratio of the maximum signal that can be handled to the smallest signal capable of being detected.

[24] The source-path-receiver model is the traditional method by which frequency management ensures electromagnetic compatibility. Applications of the model to specific environmental sources results in a determination of the conditions under which interference remains below an acceptable level at the receiver.

[25] *See RTCA/DO-235*, at F-13.

The interference susceptibility levels developed in Appendix F are based on the assumption that there is a negligible probability that a second transmitter will be operating in close proximity to a GNSS receiver. As new systems are deployed and transmitters proliferate, the probability of multiple sources of interference increases. Since the Appendix F analysis does not consider multiple sources of interference, an additional margin would be necessary , thereby reducing the allowable level of interference.

The use of interference suppression techniques to mitigate interference was also addressed in Appendix F. For the near future, the civil aviation and GNSS receiver manufacturing industries have rejected employing certain new, higher-risk interference mitigation techniques such as adaptive null-steering antennas and the vector tracking loop. These techniques have not been shown to have acceptable integrity and safety performance for civil aviation purposes. There is also a prohibitive cost associated with the implementation of these interference suppression techniques.[26]

NTIA believes that based on the existing limited C/N_0 margin, the higher interference levels associated with Category II/III operations, and the potential of multiple sources of interference, the susceptibility levels for GNSS receivers cannot be reduced from the levels assumed in Appendix F that were used to develop the out-of-band emission limits for the MSS terminals. Furthermore, NTIA does not believe that interference suppression techniques should be used as a substitute for GNSS receiver protection limits.

---

[26] *Id.,* at F-25.

V. NARROWBAND OUT-OF-BAND EMISSION LIMITS SHOULD BE SPECIFIED IN TERMS OF ABSOLUTE POWER LEVEL.

The Commission is proposing to adopt an absolute power level of -80 dBW for the narrowband out-of-band emission limit to protect GNSS receivers instead of the spectral power density of -80 dBW/700 Hz recommended in the NTIA Petition.[27] The 700 Hz bandwidth was established in Appendix G of DO-235 as the breakpoint between narrowband and wideband interfering signals. NTIA agrees with the Commission's current proposal because it is appropriate to specify narrowband emissions (*i.e.*, spurs) in terms of an absolute power level. Moreover, the narrowband out-of-band emission limit of -80 dBW is consistent with the value recommended by RTCA SC-159.

VI. THE COMMISSION SHOULD ADOPT THE OUT-OF-BAND EMISSION LIMITS IN THE 1605-1610 MHz BAND ESTABLISHED BY THE ITU-R AND ETSI.

The Commission seeks comment on NTIA's recommendation to resolve potential interference problems between MSS terminals and GNSS receivers operating above 1605 MHz on a case-by-case basis.[28] Since the NTIA Petition was filed, the ITU-R has developed and approved Recommendation M.1343 and the European Testing and Standards Institute (ETSI) developed TBR-041.[29] Both of these international documents establish out-of-band emission limits in the 1559-1610 MHz bands for MSS terminals in the 1610-1626.5 MHz band and

---

[27] *See GMPCS NPRM,* at ¶ 79.

[28] *See GMPCS NPRM*, at ¶ 83.

[29] European Testing and Standards Institute TBR-041, Satellite Personal Communications Networks (S-PCN); Mobile Earth Stations (MESs), Including Handheld Earth Stations, For S-PCN in the 1.6/2.4 GHz Bands Under the Mobile-Satellite Service (MSS) Terminal Essential Requirements (Feb. 1998).

specifically require suppression of the out-of-band emission from these MSS terminals to be linearly interpolated from -70 dBW/MHz at 1605 MHz to a level of -10 dBW/MHz at 1610 MHz. NTIA believes that it is beneficial to MSS operators and GNSS receiver manufacturers to establish out-of-band emission limits in the 1605-1610 MHz band instead of resolving interference on a case-by-case basis. Therefore, NTIA recommends that the Commission adopt the out-of-band emission limits established by the ITU-R and ETSI in the 1605-1610 MHz band. However, it should be noted that these proposed limits are intended to protect GLONASS operations in the final frequency configuration (after 2005). At that time, GLONASS should be operating with all operational carrier frequencies below 1605 MHz. In the interim, harmful interference to aeronautical radionavigation transmissions on frequencies above 1605 MHz from MSS mobile earth terminals will be resolved on a case-by-case basis.

VII. APPROVAL OF MSS HARDWARE/SOFTWARE CONFIGURATIONS IS NOT NECESSARY.

The NTIA Petition specified three options that could be used for MSS terminals that do not meet the -70 dBW/MHz and -80 dBW limits in the 1580.42-1605 MHz band by January 1, 2005. The MSS terminal had to be: (1) permanently deactivated; (2) modified in such a way that it would meet the wideband and narrow band limits in the 1559-1605 MHz band; or (3) constrained to operate only on frequencies in the upper end of the operating band, such that the wideband and narrowband limits were met in the 1559-1605 MHz band. The hardware/software implementation to restrict the operation of the MSS terminal had to be determined by the FAA as meeting air traffic control requirements. The FCC, with the concurrence of NTIA and the FAA, would incorporate the approved hardware/software implementation in the appropriate MSS licenses by January 1, 2002. If a negative finding was made, the licensing of the hardware/software will be denied by the FCC.[30]

NTIA agrees with the Commission that design decisions should be left to the MSS system providers and that requiring prior approval of hardware/software configurations could be unduly intrusive. Option 3 was included in NTIA's petition at the request of the geostationary MSS applicants with operations in the 1626.5-1660.5 MHz band. NTIA does not believe that Option 3 is necessary if the Commission adopts rules that will require all MSS terminals operating in the 1610-1660.5 MHz band to meet the wideband limit of -70 dBW/MHz and narrowband limit of -80 dBW in the 1580.42-1605 MHz band by January 1, 2005.

VIII. MEASUREMENT TECHNIQUES FOR DEMONSTRATING COMPLIANCE WITH THE RULES SHOULD BE ADOPTED TO PROTECT SYSTEMS NEEDED TO AUGMENT GPS FOR AVIATION USES.

The FAA has initiated plans to transition from its present ground-based navigation and landing system to a satellite-based system. However, GPS alone will not meet all aviation positioning requirements. To meet the National Airspace System (NAS) requirements, the FAA has proposed two augmentations to GPS: a Wide Area Augmentation System (WAAS) and a Local Area Augmentation System (LAAS). The WAAS signal will provide the augmentation to GPS to obtain the required accuracy improvement for precision approaches, as well as integrity, continuity and availability of navigation for all phases of flight. A study performed by the Johns Hopkins University Applied Physics Laboratory (JHU/APL) concluded that GPS must be augmented to satisfy navigation performance requirements and that the WAAS and the LAAS

[30] *See NTIA Petition*, at 3.

can provide the required navigation performance.[31] The JHU/APL study also considered interference to GPS and its augmentation systems and recommended that regulations be developed for all licensed transmitters that explicitly limit radio frequency emissions at satellite radionavigation frequencies.[32]

As stated in the NTIA Petition, the out-of-band emission power levels are the average values to be measured over a 20 millsecond (msec) time interval. The 20 msec time interval is related to the 50 symbols/sec data rate of the GPS/GLONASS navigation message with a corresponding symbol duration of 20 msec (1/50). However, the WAAS transmitted data stream has a data rate of 500 symbols/second with a corresponding symbol duration of 2 msec (1/500).[33] As a result of the shorter symbol duration, WAAS receivers are more vulnerable to disruption by long duration pulsed signals. The longer duration pulses will overlap more of the shorter duration WAAS symbols resulting in an increase in bit error rate (BER) and the corresponding word error rate (WER) in the data demodulation performed in GPS and WAAS (GNSS) receivers. Annex A examines the BER and WER performance of GPS and WAAS receivers. As shown in Annex A, a WAAS receiver is more susceptible to increases in BER and WER than a GPS receiver.

The baseline data rate for WAAS is 250 bits/second. The data will be ½ rate convolutional encoded with a Forward Error Correction (FEC) code. Therefore, the symbol rate

---

[31] Johns Hopkins University Applied Physics Laboratory, *GPS Risk Assessment Study Final Report* (JHU/APL Study), VS-99-007, at ES-1 (Jan. 1999).

[32] *Id.,* at ES-6.

[33] In addition to the navigation data the WAAS signal contains integrity data, ionospheric correction data, and GPS clock error correction data.

that the receiver must process is 500 symbols/second. The convolutional coding for WAAS will be constraint length 7 as standard for Viterbi coding. WAAS employs the convolutional code to partially make up for the degradation in bit energy due to its faster data rate as compared to GPS. Pulses that are longer than 2 msec will cause symbol erasures in the Viterbi decoder.[34] An erasure is a position in the demodulated sequence where the symbol value is unknown, thereby increasing the BER. The effects on the convolutional decoding will depend upon the nature of the pulsed signal (*e.g.*, random, periodic, or other).

The MSS terminals operating in the 1610-1660.5 MHz band employ Frequency Division Multiple Access (FDMA), Code Division Multiple Access (CDMA) or Time Division Multiple Access (TDMA) multiple access techniques. For MSS terminals employing FDMA or CDMA, the level of out-of-band emission are constant and the 20 msec measurement interval is adequate. However, for MSS terminals employing TDMA the out-of-band emission levels will be related to the duration of the transmission time slot.[35] In order to provide protection to WAAS receivers, NTIA proposes that the out-of-band emissions of MSS terminals employing either FDMA or CDMA be averaged over a 20 msec time interval. For MSS terminals employing TDMA the out-of-band emissions should be averaged over a time interval of duration that is equal in length to the transmission time slot. This would only apply to future MSS systems employing TDMA. For existing MSS systems employing TDMA the 20 msec averaging time interval can be used.

---

[34] Clark & Cain, *Error Correction Coding for Digital Communications*, Plenum, New York (1998).

[35] TDMA systems divide the radio frequency spectrum into time slots, which are the same as pulses, and in each time slot only one user is allowed to either transmit or receive.

Motorola recommends that the Commission allow licensees to use spectrum analyzer resolution bandwidths smaller than 1 MHz and integrate the measurements when testing for compliance with the wideband out-of-band power-density limits.[36] NTIA believes that the method of using smaller bandwidths to measure the wideband limits is consistent with ITU-R M.1343. Therefore, NTIA agrees that measurement of the wideband out-of-band emission levels in bandwidths of less than 1 MHz (*e.g.*, 30 kHz, 100 kHz, or 300 kHz) is allowable provided the power of the narrow bandwidth is integrated over 1 MHz.

IX. THE OUT-OF-BAND EMISSION LIMITS ESTABLISHED TO PROTECT GNSS RECEIVERS SHOULD ALSO APPLY TO LITTLE LEO MOBILE TERMINALS.

The Commission states that the frequency separation between the Little LEO 148-150.05 MHz band and the 1559-1610 MHz RNSS band is sufficient to ensure protection of GNSS receivers.[37] Furthermore, the Commission maintains that Little LEO terminals that operate in compliance with Section 25.202(f) of the Commission's Rules, 47 C.F.R. § 25.202(f), will not produce emissions, including harmonics, in the 1559-1610 MHz band that exceed the wideband and narrowband out-of-band emission limits established to protect GNSS receivers.[38]

NTIA disagrees with the Commission's assertion that frequency separation alone is enough to ensure protection of GNSS receivers from the unwanted emissions of Little LEO terminals. The Volpe National Transportation System Landing Systems Laboratory has performed tests to measure the unwanted emission levels that appear in the 1559-1610 MHz band

[36] *See* Comments of Motorola Satellite Communications on Petition for Rulemaking, RM 9165 (Dec. 8, 1997); see also *GMPCS NPRM*, at ¶ 80.

[37] *See GMPCS NPRM,* at ¶ 93.

[38] *Id.*

from very high frequency (VHF) transceivers operating in the 118-136 MHz band.[39] Even though a frequency separation of over 1000 MHz exists the test results show that transmitter harmonics, transmitter spurious (non-harmonic frequency) emissions, and local oscillator harmonics were found to be at levels that could potentially interfere with GPS receivers.

It is important to recognize that the issue at hand is not the frequency separation that exists between the Little LEO terminals and the GNSS receivers, but the level of the interfering signal in the passband of a GNSS receiver, as well as the potential for close proximity to an aircraft in final approach. If the interfering signal exceeds the GNSS receiver susceptibility threshold, the location in frequency of the fundamental is irrelevant since it will still cause interference. Annex B examines the out-of-band emission levels of representative Little LEO terminals assuming they are in compliance with Section 25.202(f) of the Commission's Rules, 47 C.F.R. § 25.202(f). As shown in Annex B, the levels in Section 25.202(f) are 32 dB higher than required to protect GNSS receivers for wideband emissions and 37 dB for narrowband emissions. In practice it may well be that these levels of unwanted emissions will generally be present in well designed Little LEO terminals.[40] However, NTIA disagrees with the Commission's conclusion that Little LEO terminals operating in compliance with Section 25.202(f) will necessarily produce emissions in the 1559-1610 MHz band that are not in excess of the proposed wideband and narrowband limits.

---

[39] The Volpe National Transportation Systems Center, *VHF Transceiver Emissions in the GPS L1 Band Attachment 2,* (Feb. 27, 1995).

[40] *See* 47 C.F.R. § 25.142(b). NTIA would also expect that the Little LEO requirements specified in Section 25.135 of the Commission's Rules, 47 C.F.R. § 25.135, would also be applicable.

The Commission also proposes to exempt Little LEO systems from the out-of-band emissions standards rather than require the licensees to incur the expense of establishing compliance with unnecessary restrictions.[41] It is unclear whether the Commission is proposing to exempt the Little LEO terminals from the out-of-band emission limits in Section 25.202(f) of its Rules, 47 C.F.R. § 25.202(f), or those proposed in the NTIA Petition. In any case licensees must make measurements to demonstrate compliance with the out-of-band emission limits adopted for the Little LEO terminals. In order to measure the out-of-band emissions to the limits proposed by NTIA in the 1559-1610 MHz band, the only additional test equipment that would be required is a suitable filter and low noise amplifier. Therefore, NTIA does not believe that measuring emissions in the 1559-1610 MHz band would present a significant expense to Little LEO licensees.

NTIA recognizes that a balance must be established between the development of emerging technologies and the protection of sensitive Government operations. The potential interference to GNSS receivers from little LEO MSS terminals touches upon the much broader issue of the protection of important Government operations (*e.g.*, satellite navigation, search and rescue) from the unwanted emissions of emerging mobile systems. If the unwanted emission levels are too restrictive this could inhibit the development of emerging mobile technologies. On the other hand, if the unwanted emission levels are too high, sensitive Government operations, and likely many commercial services as well, will not be adequately protected as the use of the radio spectrum increases.

[41] *See GMPCS NPRM,* at ¶ 93.

The protection of the spectrum used by GPS will be discussed in a report from the Secretary of Defense to the congressional defense committees.[42] The Secretary of Defense in coordination with the Secretaries of State, Commerce, and Transportation, the director of the Office of Science and Technology Policy, and interested user and industry representatives has been tasked to develop a national strategy to protect the integrity of the RNSS spectrum used by GPS against interference and disruption.[43]

X. THE COMMISSION SHOULD ADOPT MSS TERMINAL CARRIER-OFF EMISSION LIMITS.

Both ETSI and the ITU-R recognize that MSS terminals operating in the 1610-1626.5 MHz band have two operational states: carrier-on and carrier-off. In the carrier-on state an MSS terminal is transmitting a signal in a continuous or non-continuous mode. In the carrier-off state an MSS terminal is powered-on but not transmitting a signal. The emission limits proposed in the NTIA Petition only apply to the situation where an MSS terminal is in the carrier-on state. When an MSS terminal is in the carrier-off (*e.g.*, stand-by) state, any emissions should be held to levels that are lower than those for the carrier-on state. While this is obvious, a provision still needs to be included in the Commission's rules, otherwise the probability of more than one MSS terminal being in a position to cause interference to an aircraft in a final approach landing could become unacceptably large. NTIA recommends a limit for carrier-off that is 10 dB lower than the carrier-on limit to account for a cumulative power effect. The cumulative power

---

[42] Department of Defense Appropriations Act, 1999, Pub. L. No.105-262, §8137,112 Stat. 2279,2337(1998).

[43] See H.R. Conf. Rep. No. 746, 105th Cong., 2d Sess. 166-167 (1998)(accompanying H.R. 4103, Department of Defense Appropriations Act, 1999).

effect is attributed to the significant majority of MSS mobile earth terminals in the carrier-off state.

XI. COMPLIANCE DATES IN THE GLONASS PORTION OF THE BAND SHOULD NOT BE WAIVED OR POSTPONED AT THIS TIME.

The Commission invites comment on the possibility of waiving or postponing the compliance deadline with respect to emissions in the 1597-1605 MHz band in the event that progress toward domestic implementation of GLONASS proves slower than expected.[44] As stated earlier, the NTIA Petition proposes a time-phased approach for GLONASS protection that considered: (1) MSS terminals commissioned prior to January 1, 2002; (2) MSS terminals commissioned after January 1, 2002; and (3) MSS terminals in operation after January 1, 2005.[45] The time-phased approach was proposed by NTIA as a way to ensure protection of GNSS operations, while allowing MSS providers to proceed with system implementation.

Since the NTIA Petition was filed, there have been several key developments regarding GNSS that have occurred in the 1559-1610 MHz band. In addition to GPS, GLONASS, and their augmentation systems, there are other RNSS systems proposed for operation in this band.[46] For example, the French Administration and ESA have advanced published RNSS systems with the ITU-R that are planned for operation in the 1559-1610 MHz band. The French Medium SATellite NAVagation (MSATNAV) and the ESA E-NSS-1 satellite navigation systems have

---

[44] *See GMPCS NPRM*, at ¶ 73.

[45] *Supra* at 5.

[46] In a contribution to the Eighth meeting of Working Party 8D, the Russian Federation provided the technical characteristics for space based and ground based augmentation systems that will operate in the 1559-1610 MHz band.

been proposed for operation in the 1559.052-1563 MHz and 1587.696-1591.788 MHz portions of the 1559-1610 MHz band.

The United States is also engaged in discussions with the European Union (EU) regarding implementation of the second generation GNSS (GNSS-2) and the development of RNSS systems that are compatible and interoperable with GPS. Subsequently, the EU has proposed the Galileo RNSS system.[47] At this time, it is unknown what portion of the 1559-1610 MHz band it will operate in. One option being considered is to build Galileo from the base of the existing GLONASS system which would enable the EU to take advantage of Russia's expertise in space operations and lead to an early deployment of a European GNSS-2 satellite system.[48]

It is envisioned that one of these RNSS systems will be included in the GNSS-2. Since all of the RNSS systems operating or proposed for operation in the 1559-1610 MHz band are being designed to be compatible with each other they have similar characteristics which include a low signal level at the surface of the Earth (*e.g.*, 1 $\times 10^{-16}$ Watts). This is why the out-of-band emission limits proposed in the NTIA Petition were developed. As a result of the continuing evolution of the 1559-1610 MHz band NTIA believes that it is ill-advised to waive or postpone the 2002 compliance date for new MSS terminals proposed in the NTIA Petition. However, NTIA does agree that there is some uncertainty for the date of the domestic implementation of GLONASS. The status of GLONASS implementation should be reviewed in the 2005 timeframe and the date for invoking the final stages of compliance can be adjusted accordingly.

---

[47] *See* "Brussels Seeks European Support For Satellite Navigation System," *Telecommunications Report*, at 24 (Feb. 15, 1999).

[48] *Id.*

XII. INTERIM EMISSION LIMITS IN NTIA PETITION SHOULD NOT APPLY TO GEOSTATIONARY MSS TERMINALS.

The Commission invites comment on whether the interim wideband limit of -64 dBW/MHz (in the 1580.42-1605 MHz band) and the narrowband limit of -74 dBW (in the 1585.42-1605 MHz band) proposed in the NTIA Petition should also apply to geostationary MSS terminals operating in the 1626.5-1660.5 MHz band.[49] NTIA does not believe that it would be appropriate to apply the interim standards to such geostationary MSS terminals.

When the NTIA Petition was filed, there were no MSS terminals operating in the 1610-1626.5 MHz band; thus, there was an opportunity for such terminals to be designed to meet the interim limits prior to being placed into service. On the other hand, there are a large number of geostationary MSS terminals already in operation that could exceed the proposed out-of-band emissions levels. In recognition of this fact, NTIA proposes that geostationary MSS terminals currently in service or brought into service prior to January 1, 2002, be permitted to operate at their current out-of-band emission levels in the 1597-1605 MHz portion of the band until January 1, 2005. Geostationary MSS terminals operating in the 1626.5-1660.5 MHz band that are brought into service after January 1, 2002, however, should be required to comply with the final emission levels of -70 dBW/MHz and -80 dBW. NTIA believes that this two-fold approach will both protect current equipment investments and lessen the burden on manufacturers by allowing them adequate time to redesign their terminals to comply with the final emission limits.

---

[49] *See GMPCS NPRM*, at ¶ 70. This interim approach was fashioned to respond to a particular problem expressed at that time by a non-geostationary MSS terminal equipment manufacturer.

XIII. POSITION LOCATION CAPABILITIES SHOULD BE REQUIRED FOR GMPCS TERMINALS AUTHORIZED IN THE UNITED STATES.

The Commission seeks comment on whether to require GMPCS terminals authorized for use in the United States to have position location capabilities.[50] NTIA notes that the Commission has acted to require wireless carriers to deliver 911 and to meet a schedule for introducing the features of Enhanced 911 (E 911) calls from wireless devices such as cellular and personal communication services (PCS), whose networks are terrestrially based.[51] Effective April 1, 1998, wireless carriers are required to implement Phase I of this schedule, provided certain conditions were met.[52] Under Phase I rules, carriers must provide Automatic Number Identification (ANI) and cell site information for 911 calls to Public Safety Answering Points (PSAP).[53] Phase II, which requires the deployment of the capability to determine the location of callers, by latitude and longitude, is scheduled for October 1, 2001.[54] NTIA believes that a user in need of emergency assistance should receive help independent of which type of wireless device that person is using. This should be independent of whether the network is terrestrially based like cellular or PCS or satellite-based like GMPCS. Since the ability to locate users in distress is in the public's best interest, NTIA supports position location capabilities for GMPCS terminals authorized for use in the United States.

---

[50] *Id.*, at ¶ 98.

[51] *See generally, Revisions of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, Memorandum Opinion and Order, CC Docket No. 94-102, 12 F.C.C. Rcd. 22665 (1997).

[52] *See* 47 C.F.R. § 20.18(d).

[53] *Id.*

[54] *See* 47 C.F.R. § 20.18(e).

The United States Coast Guard (USCG) has stated that MSS systems should be included in the requirements for wireless providers to provide compatibility with E 911 emergency calling systems. It is envisioned that GMPCS terminals could be used by persons in distress in remote maritime areas. To provide effective search and rescue support it is essential that the USCG know the location of individuals in distress and be able to confirm the existence of a distress situation. In order to do this, the USCG must be able to immediately determine ANI and Automatic Location Identification (ALI) information. The ALI information is necessary to ensure that the call is routed to the proper response agency. Many of the MSS systems currently operating or planned for operation in the near future are capable of providing position accuracy within 125 meters as required in Phase II of the Commission's E911 Order.[55] For example, GPS contained in the MSS handset will provide a horizontal accuracy of 100 meters with selective availability activated.[56]

XIV. THE COMMSSION SHOULD CLARIFY WHICH EARTH TERMINALS WOULD BE EXEMPT FROM THE PROPOSED CERTIFICATION PROCESS.

The Commission appears to propose that handheld or portable GMPCS terminals, such as those permanently installed on ships, boats or planes, not be required to obtain FCC certification under Part 2 of the Commission's Rules.[57] It is unclear, however, whether the Commission seeks comment on this proposal or if the Commission proposes to exempt such terminals from the out-of-band emission limits proposed in the NTIA Petition.

---

[55] *Id.*

[56] ICD-GPS-200, NAVSTAR GPS Space Segment/Navigation User Interfaces (Public Release Version), ARINC Research Corporation (July 3, 1991).

[57] *Id.,* at ¶ 24.

If the Commission's intent is to exempt handheld or portable GMPCS terminals on ships, boats or planes from the process of obtaining the certification with the associated eligibility to use the "GMPCS-MOU ITU REGISTRY" mark, NTIA has no objection. If the intent, however, is to exempt these terminals from the emission limits proposed in the NTIA Petition, NTIA strongly disagrees. These terminals could be located in the vicinity of a GNSS receiver and pose a potential interference threat. Thus, the emission limits should be a requirement of all earth terminals.

XV. IF THE COMMISSION ADOPTS A CERTIFICATION REQUIREMENT FOR EARTH TERMINALS, NATIONAL AND INTERNATIONAL STANDARDS SHOULD BE DEVELOPED FOR SEMI-FIXED AND FIXED GMPCS SATELLITE EARTH TERMINALS.

The Commission also requests comment on whether the certification process should encompass all varieties of earth terminals, including such fixed services as Very Small Aperture Terminals (VSATs).[58] This proposal would expand the types of satellite terminals considered under the GMPCS-MoU to include semi-fixed (transportable) and fixed (village pay phones) and to include such terminals operating in the fixed-satellite service. In general, NTIA has no objection to such a certification process, but notes that it could require the development of national and international standards and recommendations for the essential technical parameters of semi-fixed and fixed GMPCS earth terminals similar to those adopted for the MSS earth terminals. In addition, operation of these terminals within the U.S. must be in accordance with the national allocation table.

[58] *See GMPCS NPRM,* at ¶ 20.

XVI. SPECIFIC EMISSION LIMITS TO PROTECT MARITIME GPS RECEIVERS MAY BE DEVELOPED.

The Commission states that the purpose of this proceeding is to adopt out-of-band emission limits for protection of only aeronautical uses of RNSS.[59] As noted earlier, however, the International Maritime Organization (IMO) has also recognized GPS and GLONASS as elements of their GNSS.[60] There are currently numerous mariners operating in-land and coastal waterways, including recreational and commercial vessels, who depend upon GPS for navigation and safety. In many instances these mariners operate their vessels with GPS receivers interconnected to automatic pilots. Both the U.S. Coast Guard (USCG) and the IMO are considering mandating that vessels required to carry radios must also carry Automatic Identification System (AIS) equipment, ship-to-ship transponders incorporating GPS receivers to aid navigation in restricted waterways and areas of heavy traffic. GMPCS compliant terminals used by operators and passengers on these vessels could cause interference to GPS receivers if adequate out-of-band emission limits are not adopted. The USCG currently supports the limits proposed by the Commission in the GMPCS NPRM. However, the USCG is considering developing interference susceptibility standards for maritime GPS receivers within the Radio Technical Commission for Maritime Services (RTCM). The results of the work performed by USCG may have to be considered in a future rulemaking on uses of RNSS other than aeronautical.

---

[59] *Id.,* at ¶ 77.

[60] *Supra* note 15.

XVII. RADIO ASTRONOMY OBSERVATIONS MUST BE PROTECTED AGAINST EMISSIONS FROM MSS TERMINALS.

The 1610-1613.8 MHz band is shared on a co-primary basis with the radio astronomy service. Radio astronomy operations are protected from MSS earth terminal emissions in Part of the Commission's Rules.[61] The National Science Foundation (NSF) requests that these rules be explicitly referenced in a Report and Order so that they are easily accessed by foreign MSS operators who may not be familiar with the Commission's Rules.[62]

The band 1660-1660.5 MHz was allocated to the generic mobile-satellite service at WRC-97, on the condition that it not cause interference to radio astronomy stations operating in this band. There is a concern that the out-of-band emissions from MSS earth terminals operating below 1660 MHz may interfere with radio astronomy observations conducted in the 1660-1670 MHz radio astronomy band. At this time the issue has not been adequately studied. Based on further studies, and experience with MSS earth terminals below 1660 MHz, it may be necessary to revisit this issue, in order to protect radio astronomy operations in the 1660-1670 MHz band, and request a tightening of the out-of-band emission standards or to introduce other measures.[63]

XVIII. CONCLUSION

NTIA urges the Commission to consider carefully the issues raised in these comments in an effort to develop a workable arrangement that would greatly facilitate global roaming of MSS terminals while protecting sensitive Government operations.

---

[61] 47 C.F.R. §§ 25.202 (e), 25.213 (a)(1), 25.213(b); *see also GMPCS NPRM,* at ¶ 19, n. 29.

[62] Memorandum from Tomas E. Gergely, National Science Foundation IRAC Representative, to Mr. William T. Hatch, Chairman IRAC (June 7, 1999).

[63] *Id.*

For the foregoing reasons, NTIA submits these comments.

Respectfully submitted,

Kathy Smith
Acting Chief Counsel

Larry Irving
Assistant Secretary for
Communications and Information

William Hatch
Acting Associate Administrator
Office of Spectrum Management

Edward Drocella
David Anderson
Electronics Engineers

National Telecommunications and
Information Administration
U.S. Department of Commerce
Room 4713
1401 Constitution Avenue, N.W.
Washington, DC 20230
(202) 482-1816

June 21, 1999

ANNEX A
BIT ERROR RATE AND WORD ERROR RATE PERFORMANCE OF GPS AND WAAS RECEIVERS

In this annex the bit error rate (BER) and word error rate (WER) of GPS and WAAS receivers will be examined. This is based on the analysis presented in Appendix C of RTCA DO-235.

Assuming a phase estimate error of ϕ, the bit error probability for the GPS message in the presence of wideband interference for binary phase shift keying (BPSK) is given by:

$$P_{b,GPS}(\phi) = 1/2\text{erfc}[(E_b/N_o)^{1/2} \cos\phi]$$

where E_b is the bit energy, and erfc(●) is the complementary error function.

The WAAS uses BPSK also, but employs a rate ½, constraint length 7 convolutional code to partially make up for the degradation in bit energy due to its faster data rate of 250 bits/sec. The bit error rate for this coding scheme, assuming a phase estimation error of ϕ, may be tightly upper bounded over the bit error rates of interest using:

$$P_{b,WAAS}(\phi) \leq \tfrac{1}{2}\,[36D^{10} + 211D^{12} + 1404D^{14} + 11633D^{16}]$$

where:

$$D = \exp\,(-\tfrac{1}{2}\, E_b/N_o \cos^2\phi)$$

The probability density function of ϕ, assuming a Costas loop is used for phase tracking, is approximated by:

$$p_\phi(\phi) = [1/(2\pi I_0(1/(\sigma_\phi)^2]\,\exp(\cos\phi/(\sigma_\phi)^2)$$

where $(\sigma_\phi)^2$ is the variance of the Costas loop phase jitter given earlier. To find the average bit error probability for GPS and WAAS requires averaging $P_b(\phi)$ with respect to the phase error distribution:

$$P_b = \int P_b(\phi)\, p_\phi(\phi)\, d\phi$$

this integral is evaluated over the range $-\pi/2$ to $\pi/2$.

The bit error probabilities for GPS and WAAS messages as a function of E_b/N_o are shown in Figure A-1. This assumes an RMS oscillator phase jitter contribution of 7.6 degree.

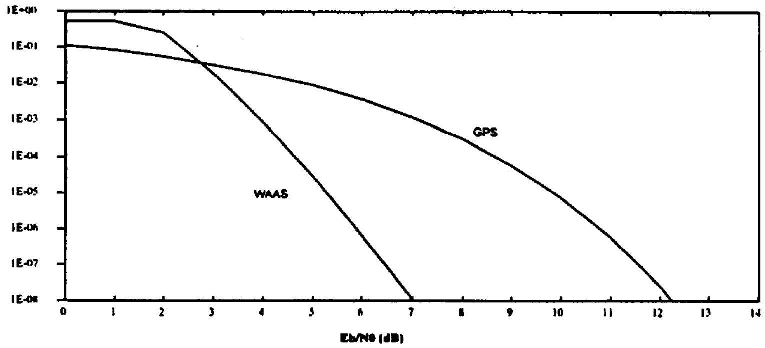

Figure A-1.

These expressions may be translated to become functions of S/N_o using the relation:

$$E_b = S/R_b$$

where R_b is the data rate (R_b = 50 bits/sec for GPS and 250 bits/sec for WAAS). Additionally, the word error rates for GPS and WAAS data may be approximated using:

$$P_W = 1 - (1-P_b)^N$$

where N is the number of bits per word (N =30 for a GPS word, 300 for a GPS subframe, and 250 for a WAAS word). The above equation is only an approximation for WAAS, since it assumes bit errors are independent whereas in actuality the errors will likely occur in bursts due to the Viterbi detection of the convolutional code. The probabilities of bit and word errors for both GPS and WAAS as a function of S/N_o using the approximation are shown in Figure A-2.

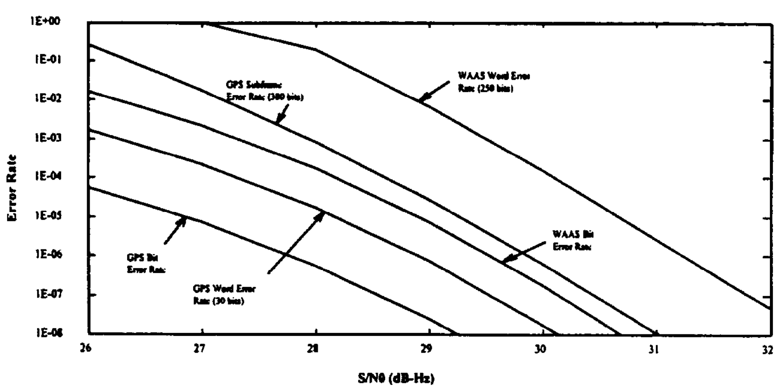

Figure A-2.

As shown in Figure A-1, as a result of the Forward Error Correction employed by WAAS small changes in E_b/N_o will result in large changes in the BER. For example, a reduction of E_b/N_o from 4.6 dB to 4 dB will increase the BER from 1×10^{-4} to 1×10^{-3}. Figure A-2 illustrates that for a S/N_o of 30 dB-Hz, which is the basis of the interference susceptibility level used to develop the proposed out-of-band emission limits, there is little BER margin available for the WAAS to meet its data demodulation WER requirement of less than 1×10^{-3}.

ANNEX B

EXAMINATION OF LITTLE LEO MOBILE TERMINAL OUT-OF BAND EMISSION LEVELS IN THE 1559-1610 MHz BAND

B.1 INTRODUCTION

This annex examines the out-of-band emission levels in the 1559-1610 MHz band from Little LEO mobile terminals. The out-of-band emission levels for terminals in compliance with Section 25.202(f) were computed and compared with the level required to protect a GNSS receiver. The additional suppression of out-of-band emission levels required to protect the GNSS receiver was then determined.

B.2 INTERFERENCE SCENARIO

The interference scenario used to develop the out-of-band limits required to protect a GNSS receiver assumes that the aircraft is in the final approach phase for a Category I precision approach landing. In the final approach phase of flight, the GNSS receiver will no longer be acquiring satellites and will be in the tracking mode of operation[64]. The interfering signal is assumed to be transmitted by a mobile terminal located beneath the aircraft at a critical decision location during final approach. At this point, if interference occurs, even for a fraction of a second, false alerts could occur that cause the pilot to perform unnecessary and unacceptable evasive actions (*e.g.*, abort the landing). The following paragraphs provide a brief discussion of the technical factors used in the development of the out-of-band emission limits to protect GNSS receivers. These technical factors include: interference criteria, distance separation, antenna coupling, and aeronautical safety margin.

B.2.1 Interference Criteria

The interference criteria used in the development of the out-of-band emission limits required to protect a GNSS receiver were derived from the interference mask cited for an aeronautical GNSS receiver. The purpose of the mask is to set the minimum requirement for interference immunity. The mask is based upon what a carefully designed GNSS receiver can tolerate while still achieving the performance necessary for precision approach navigation. The interference susceptibility levels as a function of interfering signal bandwidths less than 700 Hz up to 1 MHz are calculated using the following equations taken from Appendix G of RTCA D0-229[65].

[64] The interference protection criteria for a GNSS receiver operating in acquisition mode is 6 dB more stringent than when the receiver is operating in tracking mode.

[65] RTCA Inc., *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment*, Document No. DO-229 (Jan. 1996).

$BW_I < 700$ Hz	$I = -150.5$
700 Hz $< BW_I \leq 10$ kHz	$I = -119.5 + 6 \text{ Log } (BW_I/1000) - 30$
10 kHz $< BW_I \leq$ 100 kHz	$I = -113.5 + 3 \text{ Log } (BW_I/10000) - 30$
100 kHz $< BW_I \leq$ 1 MHz	$I = -140.5$

where,

BW_I is the transmitter bandwidth of the Little LEO terminal (Hz);
I is the GNSS receiver susceptibility level (dBW).

The GNSS receiver susceptibility level is referenced to the input of the GNSS receiver and represents the interference level that manufacturers must design to while still meeting performance requirements, it is not the allowable level of interference. GNSS receivers are not required to function while receiving interference in excess of this mask.

B.2.2 Distance Separation

The specification for the interference protection distance was determined by approach and landing operational requirements. Obstacle clearance surfaces and obstacle free zones in the runway are specified to ensure Category I continuity and integrity risks are satisfied. For Category I operations, the decision height (DH) is 200 feet above the surface of the runway. At this height, the DH is usually off airport property where the presence of the interfering mobile transmitter is not restricted. Category I operations define the front course obstacle clearance surface to be from 0 to 200 feet along the extended runway centerline. From 200 feet it increases at a 1:34 slope. The 200 foot DH is 3,816 feet from the runway intercept point. At this point, the 1:34 obstacle clearance surface height is 2616/34 = 77 feet, which leaves approximately 123 feet from the nominal glidepath to the obstacle clearance surface[66]. The GNSS antenna will in all likelihood be offset from about 7 to 27 feet above the nominal glidepath and the interfering signal source antenna could be located as high as the obstacle clearance surface. Thus, with the minimum Category I interference protection distance between the interfering source and the GNSS antenna of 100 feet, a 30 to 50 foot allowance remains for the aircraft Total System Error (TSE). Given the standard deviation of the TSE of the aircraft and its navigation system is about 15 feet, then an aircraft might be below the 100 foot minimum separation distance (MSD) at DH for only a small fraction of the approaches. With $\sigma = 15$ feet, $2\sigma = 30$ feet, this could occur for about 2.5% of the approaches. Thus, the aircraft will actually pass closer than 100 feet (123-30) on about 2.5% of approaches. The margin for this parameter cannot be reduced without the potential for interference to increase significantly. Using an MSD of 100 feet, the free space propagation loss is 66.07 dB.

B.2.3 Antenna Coupling

The interference scenario used in the development of the out-of-band emission limits to protect GNSS receivers assumed that the interfering signal source was located below the aircraft.

[66] Glidepath is a descent profile determined for vertical guidance during final approach.

RTCA DO-228 restricts the horizon gain of a GNSS antenna to between -2 dBic[67] and -7.5 dBic[68]. DO-228 does not specify, however, the antenna gain below the horizon (*e.g.*, negative elevation angles) because there is no normal signal requirements in that general direction. Negative elevation angle antenna gain is also difficult to determine and highly dependent on the specifics of aircraft installation. However, for the purpose of establishing a value to be used in determining the interference susceptibility, the nominal GNSS receiver antenna gain in the direction of the interfering source is assumed to be no greater than -10 dBic. This includes the effects of aircraft structural reflections and shadowing. Because of the lack of sufficient installed antenna pattern data on civil aircraft, the actual antenna gain can be higher due to the antenna pattern lobes available in the lower hemisphere.

B.2.4 Aeronautical Safety Margin

An aeronautical safety margin is critical for safety-of-life applications in order to account for risk of loss of life due to radio frequency interference that are real but not quantifiable. To support safety-of-life applications, all interference sources must be accounted for. In the development of the wideband and narrowband emission levels required to protect GNSS receivers a 5.6 dB aeronautical safety margin was used. This aeronautical safety margin is included to ensure protection against factors such as: multipath propagation, variations in the assumed antenna gain of the GNSS antenna, and the uncertainty of the radio frequency environment (*e.g.*, multiple sources of interference).

B.3 REPRESENTATIVE CHARACTERISTICS OF LITTLE LEO TERMINALS

The characteristics of representative Little LEO mobile terminals operating in the 148-150.05 MHz band that were used in this analysis are given in Table B-1. These characteristics were taken from a recent United States contribution to international Working Party 8D.[69]

B.4 ANALYSIS OF OUT-OF-BAND EMISSIONS FROM LITTLE LEO MOBILE TERMINALS

Using the interference scenario described in Section B.2 and the Little LEO characteristics given in Section B.3, the out-of-band emission levels for terminals that are in compliance with Part 25.202(f) will be computed and compared to the levels required to protect GNSS receivers.

---

[67] dBic is dB with respect to an isotropic circularly polarized antenna.

[68] RTCA Inc., *Minimum Operational Performance Standard (MOPS) for GNSS Airborne Antenna Equipment*, Document No. RTCA/DO-228. (Oct. 1995).

[69] Document 8D/143, Modification of Draft New recommendation, technical Parameters of Non-GSO Mobile-Satellite Service Networks with Primary Allocations Below 1 GHz, United States contribution to the Eighth Meeting of Working Party 8D.

TABLE B-1.

Little LEO System Name	Power (Watts)	Bandwidth (kHz)
LEO-L	7	15
LEO-M	5	5
LEO-N	20	30 to 50
LEO-P	1	855
LEO-Q	20	25
LEO-R	10	150
LEO-S	3	1000
LEO-T	7	2.5

For Little LEO terminals operating in compliance with Part 25.202(f) the out-of-band emission suppression level in the 1559-1610 MHz band is given by:

$$S_{25.202(f)} = 43 + 10 \text{ Log } P$$

where,

P is the transmit power of the Little LEO mobile terminal (W).

As stated in Section 25.202(f) the out-of-band suppression levels are measured in a 4 kHz reference bandwidth.

The wideband emission limit required to protect a GNSS receiver is a limit on the transmitted EIRP density. To compute the EIRP density the interference susceptibility level, the minimum distance separation (*i.e.*, minimum propagation loss), antenna gain, and aeronautical safety margin discussed in Section B.2 will be used. The EIRP density (in a 4 kHz bandwidth) of the Little LEO terminals is found using the following equation:

$$\text{EIRP} = I_{4kHz} + L_P - G_R - M_{safety}$$

where,

I_{4kHz} is the GNSS receiver susceptibility level for a 4 kHz interfering signal bandwidth (dBW) described in Section B.2.1;
L_P is the freespace propagation loss (dB) described in Section B.2.2;
G_R is the GNSS receiver antenna gain (dBic) described in Section B.2.3;
M_{safety} is the aeronautical safety margin (dB) described in Section B.2.4.

The total required suppression of the Little LEO out-of-band emissions is found by:

$$S_{req} = EIRP - 10 \text{ Log } P$$

The additional suppression of the out-of-band emission levels that is required to protect GNSS receivers is found by:

$$S_{Add} = S_{req} - S_{25.202(f)}$$

Table B-2 gives the EIRP density of the Little LEO terminals, the Part 25.202(f) suppression levels, and the amount of additional suppression that is required to protect GNSS receivers based on the proposed wideband limits.

TABLE B-2.

Little LEO System Name	Little LEO EIRP Density (dBW/4 kHz)	Required Suppression Level (dB)	Part 25.202(f) Suppression Level (dB)	Additional Suppression Required to Protect GNSS Receivers (dB)
LEO-L	-75.4	-83.9	-51.5	-32.4
LEO-M	-75.4	-82.4	-49.9	-32.5
LEO-N	-75.4	-88.4	-56	-32.4
LEO-P	-75.4	-75.4	-43	-32.4
LEO-Q	-75.4	-88.4	-56	-32.4
LEO-R	-75.4	-85.4	-53	-32.4
LEO-S	-75.4	-80.3	-47.7	-32.5
LEO-T	-75.4	-83.9	-51.5	-32.5

Table B-3 gives the EIRP of the Little LEO terminals, the Part 25.202(f) suppression levels, and the amount of additional suppression that is required to protect GNSS receivers based on the proposed narrowband limits.

As shown in Table B-2, for Little LEO mobile terminals operating in the 148-150.05 MHz that comply with Section 25.202(f) additional out-of-band emission suppression of approximately 32 dB is required to protect GNSS receivers based on the wideband limit. Table B-3 shows that an additional 37 dB of suppression is required to protect GNSS receivers based on the narrowband limit.

TABLE B-3.

Little LEO System Name	Little LEO EIRP (dBW)	Required Suppression Level (dB)	Part 25.202(f) Suppression Level (dB)	Additional Suppression Required to Protect GNSS Receivers (dB)
LEO-L	-80	-88.5	-51.5	-37
LEO-M	-80	-86.9	-49.9	-37
LEO-N	-80	-93	-56	-37
LEO-P	-80	-80	-43	-37
LEO-Q	-80	-93	-56	-37
LEO-R	-80	-90	-53	-37
LEO-S	-80	-84.7	-47.7	-37
LEO-T	-80	-88.45	-51.5	-37